Characterization of Reinforced Structural Composites with Carbon Nanotubes Grown Directly on the Fibers/Fabrics Using the PopTube Approach

Completed Technology Project (2013 - 2016)

Project Introduction

An ideal candidate to accomplish the reinforcement of the matrix and interphase zone of FRPs is carbon nanotubes (CNTs), because of their superior mechanical properties and excellent thermal and electrical properties. Direct dispersion of CNTs into the matrix of the composites has been shown to be very difficult. A more effective way to reinforce FRPs using CNTs is to grow CNTs directly on the reinforcing fibers/fabrics. At The University of Alabama and Auburn University, a novel technique used to grow CNTs directly on micro-fibers has been developed. This method, referred to as the PopTube Approach, uses microwave irradiation to grow CNTs at room temperature in air, without the need for inert gas protection or additional feed stock gases. Compared to other existing manufacturing methods of CNTs, the PopTube Approach enjoys many advantages: little damage/chemical alteration is induced in the fibers; high-yield, large-scale manufacturing requires only simple equipment; and energy efficiency and cost effectiveness is greatly enhanced. The objective of this study is to evaluate the potential of the PopTube Approach to produce reinforced structural composites with CNTs grown directly on the fibers/fabrics to achieve superior mechanical performance and long-term durability. This objective will be accomplished through the implementation of a systematic experimental program designed to 1.) Evaluate the effects of the use of PopTube Approach-engineered fibers/fabrics on the manufacturability and mechanical properties of the composites through manufacturability characterization and multi-scale mechanical characterization of the hybrid material; and 2.) Assess the long-term durability of the CNT/FRP composites through a series of fatigue, creep and low-speed impact tests. The proposed research aims to develop and characterize a novel approach to the manufacture of carbon nanotube-reinforced structural composites. This work could lead to the next generation of high-performance hybrid materials, which would have direct applications in aerospace technology, particularly in structural materials used in spacecraft.

Anticipated Benefits

The research aims to develop and characterize a novel approach to the manufacture of carbon nanotube-reinforced structural composites. This work could lead to the next generation of high-performance hybrid materials, which would have direct applications in aerospace technology, particularly in structural materials used in spacecraft

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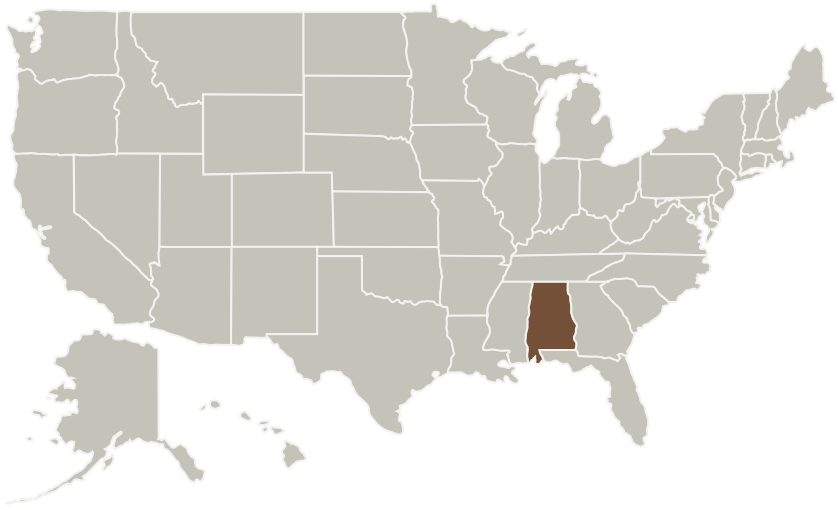
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
The University of Alabama	Lead Organization	Academia	Tuscaloosa, Alabama

Primary U.S. Work Locations
Alabama

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

The University of Alabama

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

Jialai Wang

Co-Investigator:

Will Guin

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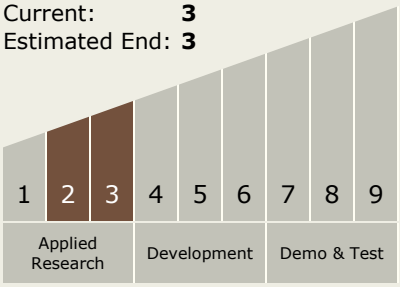
Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.1 Materials
    - TX12.1.1 Lightweight Structural Materials

Target Destination

Mars